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RESIDUE VISCOSITY GRADING SYSTEM FOR PAVING ASPHALTS

By George B. Sherman*

Since the start of hot mix paving, asphalt has been graded on the basis of the consistency of the original asphalt when it leaves the refinery. This consistency is measured using the penetration test at 77°F and is specified in decimillimeters with bracketing requirements for each of 5 existing grades. For example, the most common California grade is 85-100 penetration asphalt.

Until recent years, the Penetration Grading System has generally been satisfactory except for occasional "setting" problems before and after rolling operations. As asphalt becomes more scarce due to increased use of fuel oil, a wider variety of foreign crudes is entering the California market. At latest count, we have been informed that there are at least eleven foreign crudes being used on the West Coast. Asphalts meeting existing penetration grade paving asphalt specifications that are manufactured from these different crudes have a wide range of viscosities after mixing in the pugmill. This wide difference

*Chief, Pavement Section, California Transportation Laboratory,
5900 Folsom Boulevard, Sacramento, California.

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is due to a combination of temperature susceptibility and the amount of asphalt hardening during the mixing period.

The penetration test is an empirical test whereas the viscosity test is a measure of the actual ability of the material to flow and is considered a basic measurement. Since differences in viscosity will result in differences in the percent of asphalt used in a mix, viscosity becomes critical when different types of asphalt are furnished to the same project for use with the same aggregate.

These problems have not only been recognized on the West Coast but have also been recognized nationally. The Federal Highway Administration has recommended to all States that viscosity specifications be adopted as soon as practical. The American Association of State Highway Officials has included in their standards viscosity specifications for grading asphalt.

At the 1971 Pacific Coast Conference on Asphalt Specifications, a committee was appointed to develop improved specifications for the wide variety of asphalts available in California. As a result of this action, the representatives of asphalt user and producer agencies in attendance at the 1972 meeting of the Pacific Coast Conference on Asphalt Specifications agreed on specifications based on the residue viscosity grading system. Adoption of this specification on January 1, 1974, was reaffirmed at the Eleventh Conference in May of 1973. This conference

included the representatives of six States, the Cities of Los Angeles and San Jose, the Counties of Los Angeles and Contra Costa, the Federal Highway Administration, the Army Corps of Engineers, the Federal Forest Service, the Federal Aviation Administration, and all of the West Coast asphalt refiners who cared to attend.

The new concept for grading asphalt is based on the viscosity after a treatment called the "Rolling Thin Film Test." The Rolling Thin Film Test simulates pugmill action relative to asphalt hardening and puts the asphalt at about the same viscosity as exists when the mix is delivered to the street. Viscosity is measured at 140°F on the asphalt residue and specified in fundamental viscosity terms. By using this specification, it was felt that all asphalts would be graded so that at the time of compaction on the street they would have approximately the same viscosity and, therefore, workability differences attributed to the various crudes would be eliminated and a uniform product would result. Field tests to date have confirmed that this is exactly what happens.

We believe that the use of these new specifications will provide more uniformity. For instance, the wide workability differences between the same penetration asphalts of the California Coastal and Valley asphalts will be minimized. There is a definite need for more uniformity between asphalts at this time because

one supplier does not always furnish asphalt for the complete contract. In recent years we have had as many as four suppliers furnish asphalt for the same contract with asphalts being manufactured from widely different domestic and foreign crudes.

In devising the new specifications, tests were performed on different grades of asphalt from three widely differing types of crude oil. Results of these tests are indicative of the wide differences between asphalts now furnished on the West Coast.

Figure 1 shows the range of viscosity for different penetration grades now currently being purchased on the West Coast. It is possible to buy an 85-100 grade that is the same as a 60-70 grade from another crude source. It is also possible to buy an 85-100 grade which is the same as a 120-150 penetration asphalt. There is a large overlap in viscosities in the current asphalts. However, remember that this is only the way the asphalt arrives on the job and the way it enters the pugmill. While this may have some bearing upon the spraying of the asphalt for mixing in the pugmill, this is not the condition of the asphalt when it arrives at the road because different amounts of volatiles are lost in the pugmill.

Figure 2 illustrates the differences in asphalts after the Rolling Thin Film Test, which simulates pugmill mixing. Now it can be seen that for any given penetration grade there is an overlap of three grades so that 60-70 asphalt from one

California source might be the same as 85-100 or even a 120-150 from another area.

In order to eliminate this overlap, specifications have been devised which are illustrated on Figure 3. It shows the viscosity ranges which will be allowed by the new AR gradings and indicates that viscosities will no longer overlap.

Finally we come to the new specifications. On Figure 4 it will be noted that there are five different grades of asphalt. This is the number of grades now being used on the West Coast under Penetration Specifications. For normal asphalt concrete usage it is expected that AR-4000 will be used. For higher elevations or for cold climates AR-2000 or AR-1000 is recommended and for industrial uses (parking lots or heavy duty work areas) AR-8000 and AR-16,000.

It will be noted that the viscosities are based on the residue from the Rolling Thin Film Test. This test was modified about two years ago to include a circulating system to provide more uniform temperature conditions. The modified test has been designated as the "RTFC", the "C" standing for "Circulating." Viscosity of the residue is determined by the standard AASHO T-201 test.

In order to provide some control on the viscosity temperature characteristics, a minimum viscosity at 275°F is also specified and a penetration at 77°F is required. In order to prevent

undue loss of consistency in the mixing process, a percent of original penetration has been established with the minimum value shown in the table. Ductility is required to provide a product that at least has some stretchability at 77°F. The only specification tests required on the original asphalt are the flash point for safety reasons and the solubility in trichloroethylene to control the impurities in the asphalt.

The California Division of Highways has tried the new specification asphalts on three projects. The U. S. Forest Service has tried one project. Two of the Highways' projects were in the higher elevations and AR-2000 was specified. One product came from California Coastal crude and complied with all the specifications for AR-2000. Its original penetration averaged 230 with a residue 140°F viscosity of 1907 poises. The second project used an AR-2000 grade and was manufactured from a California Valley crude. The original penetration of this material was 70 with a residue 140°F viscosity of 1994 poises. These two projects represent the extremes of crudes being used in California. In both projects the materials handled similarly, the same contractor did both jobs, and insofar as we were able to determine, there were no problems with placing or mixing that could be considered the fault of the asphalt.

The project which used the Coastal AR-2000 also had part of the project paved with a 120-150 penetration asphalt which also complied with the AR-2000 specification. This latter asphalt

was, however, made from Arabian crude. The only difference between the penetration Arabian crude and the California Coastal crude was that the latter seemed to smoke more in the mixing and placing process. Otherwise, the paving personnel could tell no difference.

The Forest Service tried an AR-2000 made from Coastal crude (177 original penetration at 77°F) on a paving project high in the Sierra Nevada mountains. This project also used a dryer drum process for mixing. Some minor coating problems were observed but it is not believed that these were due to the type of asphalt.

One trial using an AR-4000 was made by the California Division of Highways. The original penetration of the material averaged 59 with a residue 140°F viscosity of 3314 poises. No problems were encountered in spreading, loading, or compacting, and there were no coating problems.

In using the new specifications the composition of the asphalt is not really being changed, merely the consistency. It can be expected, however, that anything which happens on the project will be blamed on the asphalt change in specifications. For example, on one project the plant man blamed erratic extraction results on the new asphalt. On another project coating problems were blamed on the new asphalt, but in this latter case a dryer drum was also involved. One Resident Engineer thought that the

asphalt foamed during the rain. A Maintenance Superintendent purchasing mix from the plant doing a highway job found that the asphalt mixture was too stiff for him to work with the blade.

One of the problems that will be encountered is that paving people have been adjusting the grade of asphalt they use to conform to the source of the asphalt. For example, one of the California counties has historically used a 60-70 grade because the nearest available asphalt contained a high percentage of lubricating oil which results in a relatively low viscosity for any specific penetration as compared to other asphalts. This county has tried the new grading scheme and finds that an AR-8000 (the equivalent of 60-70 penetration) is too heavy for their use and in the future will use AR-4000. In other words, the new specifications have made the necessary compensation in consistency so that they can get an adequate stiffness into their mix without changing grades to adjust for different sources of the asphalt.

To date, acceptance of the residue viscosity grading system has generally been good on the West Coast, both from producer and consumer organizations, and we have been assured by the refineries that these asphalts will be available on January 1, 1974. We anticipate some confusion during the change-over period but believe that after a few months the new grades will be

adopted and accepted by all agencies on the West Coast. Finally, we believe that the use of uniform consistency at the time the mix is compacted into a pavement will aid in achieving a better product for highway use.

WEST COAST ASPHALTS ORIGINAL ASPHALT VISCOSITY VS PENETRATION GRADES

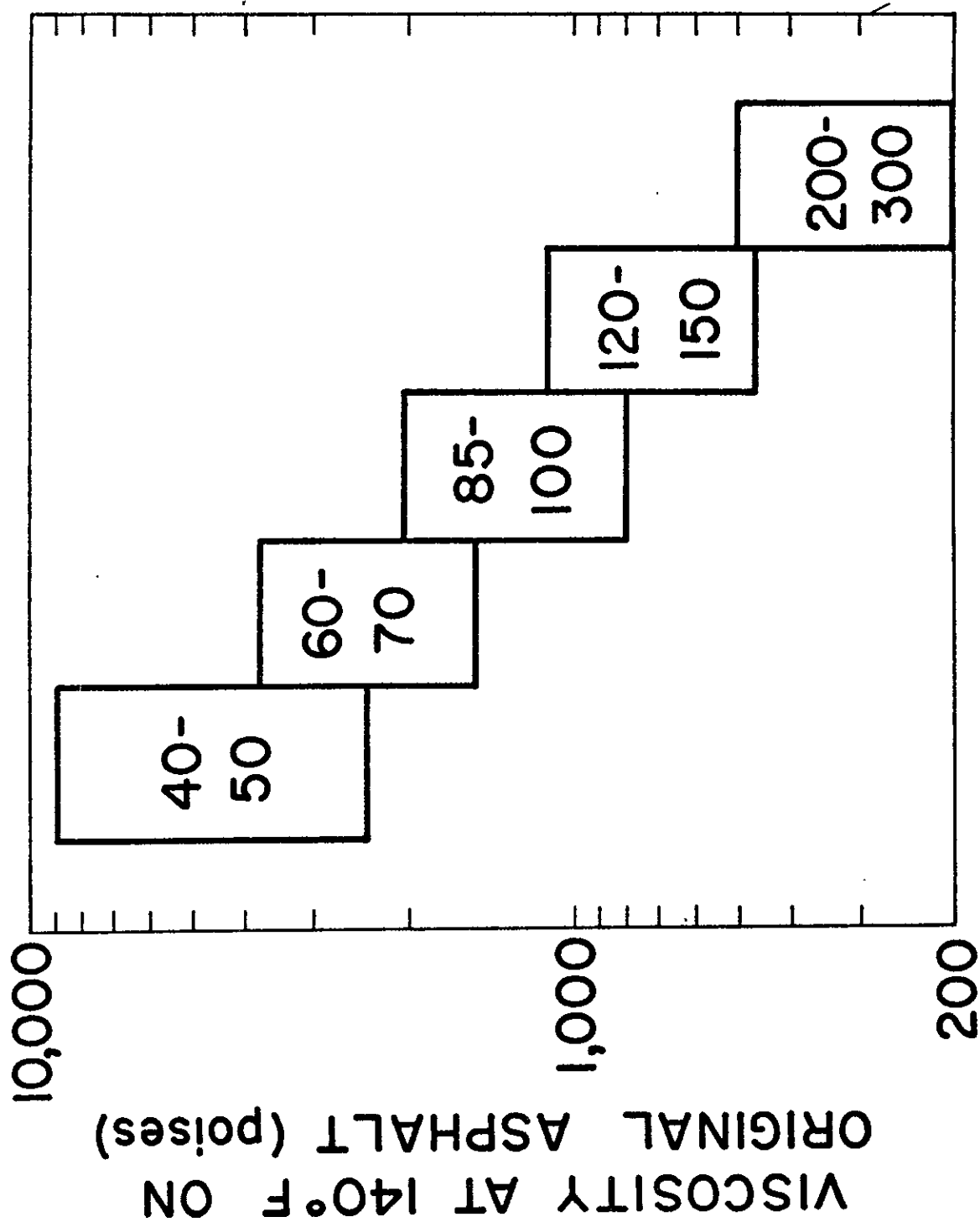


Figure 1

WEST COAST ASPHALTS

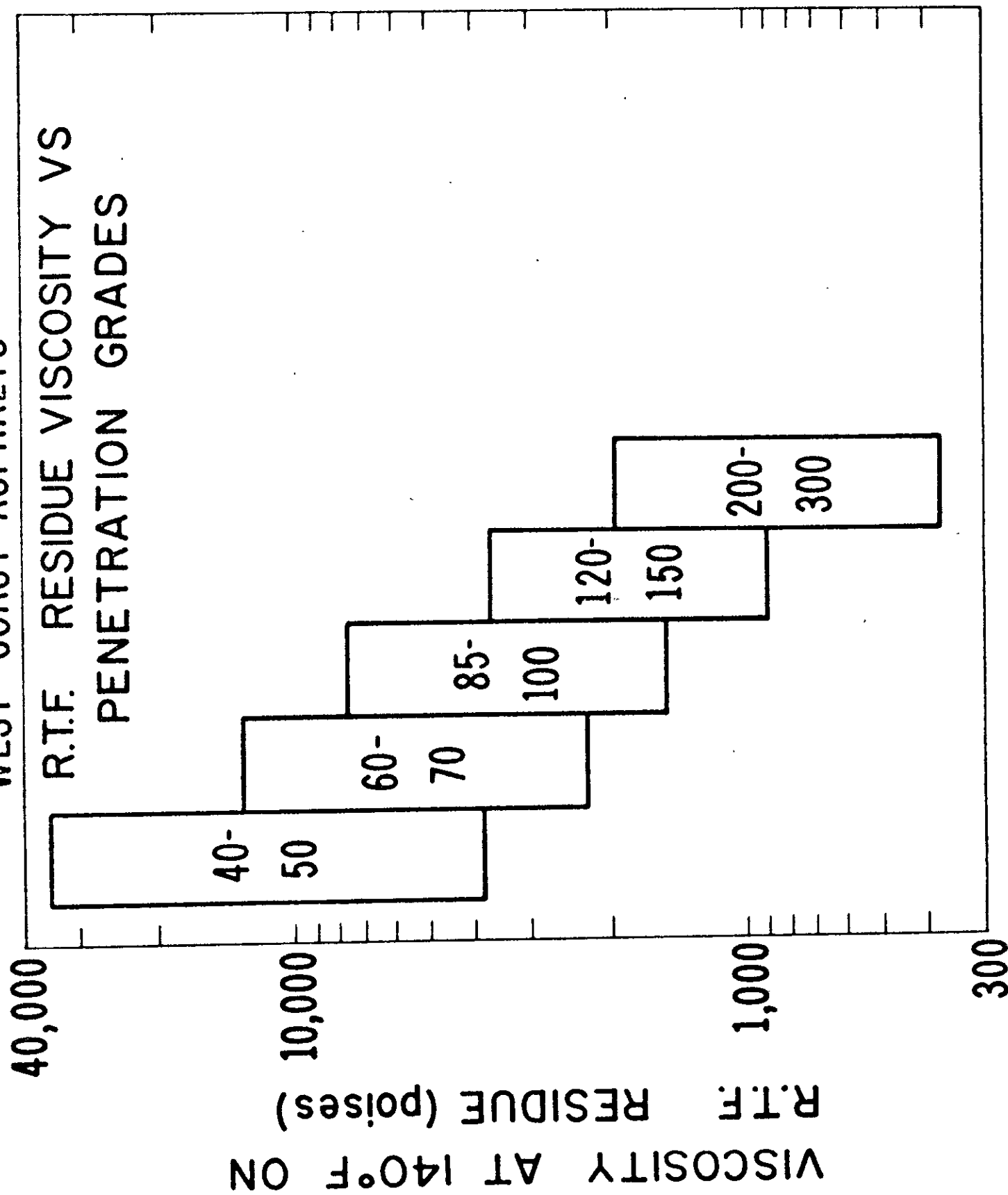


Figure 2

WEST COAST ASPHALTS

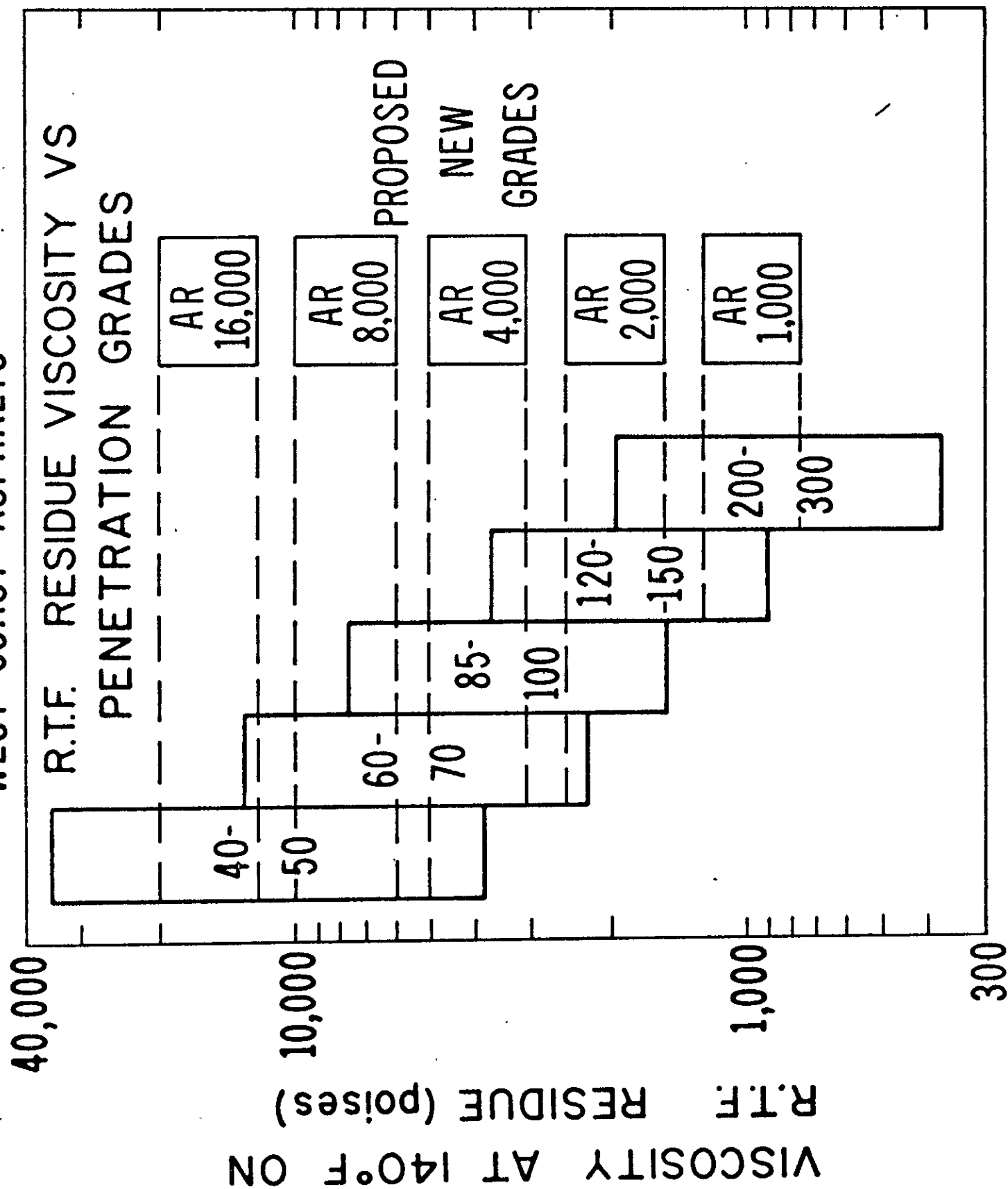


Figure 3

Asphalt Cements

Viscosity Graded at 140°F (60C) on Rolling Thin Film (RTFC) Residue

Specification Designation Tests	AASHTO Test Method	Viscosity Grade				
		AR-1000	AR-2000	AR-4000	AR-8000	AR-16000
On Residue from RTFC Procedure-Calif. Method 346E*						
Abs. Vis. at 140°F, poise	T-202	750-1250	1500-2500	3000-5000	6000-10000	12000-20000
Kin. Vis. at 275°F, cs, min.	T-201	140	200	275	400	550
Pen. at 77°F, 100g/5 sec, min.	T-49	65	40	25	20	20
% of original pen. at 77°F, min.	***	---	40	45	50	52
Ductility at 77°F, cm, min.	T-51	100**	100**	75	75	75

On Original Asphalt

Flash point, P.M.C.T., °F, min.	T-73	400	425	440	450	460
Sol. in Trichloroethylene, %, min.	T-44	99	99	99	99	99

*TFO (Thin Film Oven) may be used but RTFC (Rolling Thin Film Circulating) shall be the referee method.

**If the ductility at 77°F is less than 100 cm., the material will be acceptable if its ductility at 60°F is more than 100 cm.

***Original penetration as well as penetration after RTFC loss will be determined by AASHTO Test Method T-49.

LAASHTO M226 Table III

Note: The following are the recommended AR-Viscosity replacement grades for the penetration grades: Normal asphalt concrete usage - AR-4000, for higher elevations, cold climates - AR-2000 or AR-1000, for special or industrial use (parking lots, etc.) - AR-8000 and AR-16,000.